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AD-A231 632

Strategies for Improving Labor and Equipment Data Acquisition for the Heidelberg Directorate of Engineering and Housing

by
Roger Day
Wayne Schmidt

Acquisition of labor and equipment (L&E) data is an essential activity for Army installation Directorates of Engineering and Housing (DEHs). This data is necessary for accountability and mission reporting requirements. Current methods of collecting L&E data result in an unacceptably high proportion of incorrect submissions and significant costs for entering the data into a host system. The DEH at the U.S. Army, Europe at Heidelberg, Federal Republic of Germany, is seeking ways to improve L&E data acquisition methods. Improvement should be realized in the form of reduced acquisition costs in terms of employee time use (productivity) as well as in significant reductions in incorrect submissions of L&E data.

The U.S. Army Construction Engineering Laboratory (USACERL) has surveyed multiple DEH organizations and the current state of computer technology to identify strategies for addressing L&E data acquisition problems at Heidelberg. This report summarizes the findings and makes specific recommendations. The major recommendation is to pursue pilot testing and implementation of push-button station technology. Together, the hardware and software components of this technology offer entry method options (push-buttons, keyboard, barcodes), ability to screen for incorrect data, and meaningful reporting. Reasonable implementation costs, strong vendor support, high likelihood of acceptance, and the promise of notable return on investment strongly support this recommendation. It is also proposed to implement an educational program on the purpose, importance, and benefits of correct L&E data submission, including interim improvement of the current manual system and expansion of microcomputer networks for improved distribution of data, communications, and problem resolution. A scanner test in progress at Grafenwoehr and barcode research at USACERL should be reviewed when the results become available. Preparation for the fielded IFS-M is also recommended.

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REPORT DOCUMENTATION PAGE

1. AGENCY USE ONLY (Leave Blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	January 1991	Final

4. TITLE AND SUBTITLE
Strategies for Improving Labor and Equipment Data Acquisition for the Heidelberg Directorate of Engineering and Housing

5. FUNDING NUMBERS
PO GGVK8223

6. AUTHOR(S)
Roger Day and Wayne Schmidt

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Army Construction Engineering Research Laboratory (USACERL)
2902 Newmark Drive, PO Box 4005
Champaign, IL 61824-4005

8. PERFORMING ORGANIZATION REPORT NUMBER
TR P-91/09

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

26th Support Group (DEH)
ATTN: CMESB
APO NY 09102-5347

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

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14. SUBJECT TERMS
labor   Directorate of Engineering and Housing
equipment   US Army, Europe, Heidelberg
data acquisition

15. NUMBER OF PAGES
40

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

FOREWORD

This work was performed for the Directorate of Engineering and Housing, 26th Support Group, U.S. Army Europe, Heidelberg, Federal Republic of Germany, under Project Order GGVK8223, "Automation of L&E Cards." The Technical Monitor was John P. Snead, CMESB.

The study was conducted by the U.S. Army Construction Engineering Research Laboratory (USACERL) Facility Systems Division (FS). Dr. Michael O'Connor is Chief, USACERL-FS.

COL Everett R. Thomas is Commander and Director of USACERL, and Dr. L. R. Shaffer is Technical Director.

CONTENTS

Accession For

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STRATEGIES FOR IMPROVING LABOR AND EQUIPMENT DATA ACQUISITION FOR THE HEIDELBERG DIRECTORATE OF ENGINEERING AND HOUSING

1 INTRODUCTION

Background

Directorates of Engineering and Housing (DEHs) are primarily responsible for operations and maintenance (O&M) at their installations. This function requires the management of many resources daily. Routine tasks, most of which are coordinated manually, have become complicated by the large volume of data related to labor and equipment (L&E) usage. This situation presents a management problem because collection of accurate L&E data is essential to provide accountability and meet reporting requirements for the DEH.

The main drawbacks with current management of L&E data are the methods of collection, the high cost of data entry, and the poor accuracy of the resulting data base. Meaningful analysis of workload data depends on complete, accurate entry of L&E usage at the time work is performed. However, recent studies on the effectiveness of Army preventive maintenance programs and analysis of historical workload information for potential commercial activities (CA) have revealed that much of this data is inaccurate, incomplete, or both. These errors are largely due to incorrect entries on the L&E cards used in collecting the data and to incomplete recording of work completed. Inconsistent use of task codes also has led to incorrect workload records.

The U.S. Army, Europe at Heidelberg, Federal Republic of Germany, is seeking ways of improving its current method of handling L&E data. At present, the Heidelberg DEH uses the Integrated Facilities System (IFS) to store the data. With this system, clerks key in L&E data that has been read from paper forms collected from the employees/shops.

The ability of computer technology to store and manipulate huge amounts of information suggests that L&E data collection could be automated. Therefore, the Heidelberg DEH has asked the U.S. Army Construction Engineering Research Laboratory (USACERL) to investigate this possibility and identify approaches that could improve productivity, reduce the cost of data entry, and result in fewer errors.

Objective

The objective of this work is to survey current methods of managing L&E data, review state-of-the-art automated technology for potential application, and recommend an approach that will best address current problems with L&E data collection, entry, and accuracy at the Heidelberg DEH.

Approach

USACERL visited Heidelberg to analyze the current operating procedures. In addition, several installation DEHs in the continental United States (CONUS) were surveyed to learn about their L&E data collection methods. The information obtained was used to identify weaknesses in the current practices and opportunities for exploiting automation to improve efficiency. Next, the market was surveyed for automated systems that could potentially serve the DEH's needs. Those systems that looked promising were examined in more detail. Automation strategies were developed based on findings from the review of operations and commercial software; recommendations are given in this report.

Scope

Automation technologies covered in this report include scanners, microcomputers, barcoding, and pushbutton stations. Several promising technologies were not evaluated in detail because they are still immature (e.g., the ability to scan barcodes on a monitor rather than from paper, voice recognition, and natural language interfaces). This report is intended only to state the problems, challenges, and expected results from each strategy examined; it is not within the scope to resolve all issues connected with automating the DEH or to calculate exact costs and benefits. The recommendations developed for the Heidelberg DEH may not apply to all Army installations due to the foreign location of that activity.

2 CURRENT OPERATIONS AT HEIDELBERG

Like other DEHs, the Heidelberg DEH is composed of divisions organized according to functional responsibilities such as Housing, Fire Protection, Buildings and Grounds, Utilities, and Engineering Plans and Services. The divisions are subdivided into more specialized branches and sections. The DEH employs foreign nationals to supplement its workforce.

As noted in Chapter 1, Heidelberg uses IFS, which requires manual collection and entry of L&E data. The data is often written or summarized multiple times. Shop foremen must recopy and summarize L&E data on summary report forms. To obtain this information, they must ensure that those they supervise are submitting it as required. This data collection and reporting is a time-consuming task that takes the foremen away from their regular work. (Surveys of CONUS DEHs showed that shop foremen devote an average of 2 hr per day to working with L&E data and an additional 3 hr to preparing other paperwork, some of which is related to L&E.)

Other offices at the DEH are responsible for completing the various reports that require L&E data. Here, the data often is entered into a microcomputer that will help in producing the reports. Again, L&E data is taken from forms and manipulated manually (by keying it into the computer).

IFS-M researchers hope to eliminate both the redundant data entry and the need for handwritten reports and summaries. Indeed, the benefits of decisions made after reviewing informative reports from IFS-M data (e.g., resource allocation and productivity trend reports) hold the most potential for dollar savings at the DEH. If the significant reduction or elimination of handwritten reports at the shop level is realized, increased productivity can be expected. For example, since the shop foremen are often master craftsmen, freeing time for them to devote their personal skills to shop work could be expected to increase productivity.

Currently, the equivalent of two full-time employees enter L&E data from handwritten forms into IFS. When incorrect data is entered, IFS often rejects it. Institutional knowledge needed to recognize why data is rejected requires at least 3 months of job experience for the data entry clerk. In addition, correcting the data requires time-consuming research, during which the clerk may have to call upon other individuals for help. Although researching the reasons for rejected entries may not be an official duty of the data entry clerk position, the clerks perform this task.

If the number of rejected data entries could be essentially eliminated, data entry clerk labor could likely be reduced by 50 percent. In addition to creating a bottleneck at the computer, inaccurate data means that many manhours must be devoted to correcting it. One clerk also commented that she could type faster than the system could accept input; this is a common situation with many minicomputer and mainframe data entry programs.

Errors can occur when data from handwritten forms is keyed incorrectly into IFS. This error rate in transcribing the information, some of which is due to poor legibility, may be about 5 percent. However, failure of employees to write correct data on the L&E card is the principal source of errors. The total error rate at the Heidelberg DEH may be as high as 25 percent. Error rates of 30 percent have been reported by several other DEH organizations.

The IFS-M addresses many data handling problems in the DEH. However, methods of collecting and entering L&E data still need to be improved. Although automated systems can reject some incorrect data, effective methods for assuring greater initial accuracy at the source--the employee--are needed. (The U.S Army Engineering and Housing Support Center [USAEHSC] is currently sponsoring research at USACERL to investigate the feasibility of using barcode technology as a data entry method for IFS-M. Different types of barcode hardware and software are being tested and a report on the work is scheduled for the end of FY91.)

Any automation technology must be viewed as a tool to be employed by DEH personnel in day-to-day work and must be selected accordingly. It is also important to note that any tool selected for implementation by the DEH must be introduced appropriately to personnel who will use it. This introduction must include training and other efforts to ensure proper usage and encourage employees to take maximum advantage of computer tools. These issues are examined further in Chapter 3.

3 HUMAN FACTORS TO CONSIDER BEFORE AUTOMATING

Definition and Importance

The "human factor" is a term to characterize the often unreliable response of persons to various requirements and tasks as a result of their perceptions No matter how well conceived a manual or automated system might be, failure to consider that humans must understand and take part in its success will likely lead to discouraging results. The human factor must be considered in the big picture of each automation strategy and addressed as much as possible in designing every system.

An important issue to consider for automation is the human factor reponse to data entry. The nature of "data entry" has made it one of the most feared terms related to automation. The tediousness of this task is a problem that has been pervasive since the introduction of automated systems. Many attempts have been made to disguise the data entry task or make it more interesting, but the basic procedure has remained unchanged. Rather than focusing on easier methods of data entry, it is essential to consider the human factor--the ways in which human beings respond to automation and data entry in particular. However, easy the mechanics of entering or submitting data become, addressing the thought process that causes a person to undertake the task and perform it as best as possible is paramount. The first way to engage this thought process is through education.

Education Required

Training must be scheduled for everyone who will handle L&E data at Heidelberg. Since virtually every person must submit L&E data, education must be provided for all (military, administrative/ civilian, and shop/other employees). Methods of communicating key guidance may need to be adjusted to compensate for differences in language and educational level. Topics that need to be addressed are (1) the purpose, importance, and benefits of the activity, (2) the mechanics of using a particular system or technology, and (3) examples and exercises to effect proficiency with the system. Biennial refresher training should also be part of this education.

Human response to computers can take several forms, ranging from unrealistic expectations to highly negative attitudes. Some new users assume computers can do anything, while others become convinced they cannot do anything. Resentment of that which is not understood or which represents the performance of a task perceived as distasteful and providing few or no benefit(s) can lead to reluctance to use a system. Therefore, one of the goals of education is to present a realistic, practical view of automated systems by addressing the above topics.

Current Attitudes

The current attitudes of DEH personnel who use the minicomputer host are varied and represent the full spectrum. Some individuals see automation as a solution, while others perceive only another "job to do." Of interest are findings from a questionnaire administered to DEH shop managers at 9 CONUS installations, ranging in size from small to large. The 94 responses (of 120 sent) revealed that 31 percent of shop managers currently use some form of automation--typically the microcomputer. Of those without automation, 67 percent felt that automation could enhance their ability to perform their duties. Whether such opinions are based on actual knowledge or simply expectations, these results indicate that it is reasonable to consider introducing automation at shops currently using manual methods of data collection.

Addressing the Paper System

Automation strategies reviewed in this study that do not require electronic entry of data by all employees will require that some or many employees continue to use pencil and paper. Any strategy that would require direct entry of data through automation by all employees would likely be implemented in phases, again resulting in use of a paper system by some until implementation is complete. As discussed above, training is essential to the success of any system, including a manual system. By understanding how to implement a paper system properly, employees should be able to use an automated system more effectively, as well. Elements of a successful paper system are summarized below.

Because of the time required to complete forms, the design of the form from both graphic and explanatory text standpoints is important (see Appendix A for current forms used at Heidelberg). Although a fairly small number of data elements is required for the L&E card submission, instructions and/or training should be available for new employees. German language forms and instructions are appropriate for some foreign national employees at Heidelberg DEH.

Currently, employees are issued address size stick-on labels with their name, social security number, and shop or office code to apply to their form. This practice is used at several other DEH organizations, as well. Some employees do not like to use the stick-on labels and instead choose to write the information each time. A solution that would avoid either applying a label or filling out the information each time is to copy a supply of L&E cards for each employee with this basic unchanging information already entered. One sheet of paper for each employee with the basic information printed in the correct position, but which is otherwise blank, can be used for copying to L&E cards that have been placed in the copy machine paper tray.

The frequent use of invalid codes on L&E sheets indicates that it is essential to provide each employee with a list of valid codes. Currently, lists are posted on the wall in most office areas and shops for reference (see Appendix A). When these lists are updated, the changes could be distributed to each employee instead of being posted. Office employees tend to memorize the number to which they consistently charge their time. However, for the shop worker, the situation is far different and the possibility of error much higher due to the volume of work passing through the shop and therefore the large number of codes. Shop workers may benefit from making a copy of each order that they handle for ease of personal reference and for writing the bill of materials used for the order. If access to a nearby copy machine is not currently provided for shop employees, granting access and, if necessary, purchasing copiers should be considered. In any case, the practice of writing the bill of materials on the back of the original work order sent back to the administrative office should be abandoned. It is the shop foreman who is interested in the materials used and that information should logically remain within the bounds of the shop for easy reference.

To ensure that employees are fully aware of the importance of the paper system and are supplied with the information necessary to do their part, an L&E binder or notebook could be created for each person. This notebook should contain instructions on the L&E process, a supply of forms, a section for copies of past L&E card submissions that an employee wants to retain for reference and, in the case of the shop worker, a section for copies of work orders, service orders, and bills of material for reference. Implementing an educational program, providing the notebook, and the other actions discussed above should result in less time-consuming, more accurate L&E card submissions by employees, while reinforcing the importance and awareness of the L&E process.

4 AUTOMATION-BASED TECHNOLOGIES

All data systems have several key parts that must be examined in choosing appropriate systems: data base design, data maintenance, and data entry. Closely related to data entry are data collection and data accuracy. For this study, data collection, entry, and accuracy are combined under the umbrella term "data acquisition."

The market was surveyed for technologies that could have potential application at the Heidelberg DEH. Four were identified as promising: scanners, microcomputers, barcoding, and pushbutton stations. These technologies were evaluated for their expected performance in data acquisition. The cost of implementation, ease of use, likelihood of addressing current problems successfully, level of acceptance by DEH personnel, and return on investment (ROI) were estimated for each. User responsibilities and required skills also were assessed. Although some of these technologies will not be recommended for adoption, a discussion of each is useful to add perspective to the problem at hand and to appreciate the type of issues that must be resolved in selecting automated systems for organizations like the DEH.

Scanner Technology

Scanners are peripheral devices, usually used in conjunction with microcomputers, that allow electronic information from paper to be input into the computer. Scanners are sometimes referred to as optical character readers (OCRs), although most scanners also can read in an image from paper as an electronic graphic file, regardless of the type of image (e.g., text, graphics, photograph).

As with most automation products, scanners are available with a full range of capabilities and prices. Scanners at the low end of the spectrum must be "trained" to read text or graphics in the desired manner. Some must always be instructed as to what font or type style will be read. The number of formats in which a graphics file can be saved varies greatly among scanners. The more sophisticated scanners can now be trained to read handwriting. Such a scanner, the Polyform PFL 6150 by AEG Corporation, is being tested at the Grafenwoehr DEH. The results of that test are not yet available.

Uses of Scanner Technology

While a scenario could be visualized in which there would be a need to read forms printed by one computer into another computer, this arrangement strongly implies duplication of entry. In applying the scanner's graphics ability to the L&E process, each L&E card might be scanned as a graphics file, stored on high-capacity optical disk media, and recalled via a data base application. This use of scanning could be beneficial for storage and recall of documents. However, such a graphics-based system would not enter the L&E data into IFS-M. In the scanning application being tested at Grafenwoehr, the scanner reads hand-printed characters and numbers that have been placed in clearly defined boxes on specially designed L&E forms (Appendix B) and passes the information into the minicomputer.

Scanner Implementation Issues

The cost of implementing scanner technology like that at Grafenwoehr includes the costs of (1) the scanner (approximately $75K as of this writing), (2) printing specially designed L&E card forms in the quantities required each year, (3) training for employees and operators, (4) employee time devoted to training and operating the scanner, and (5) a repair/maintenance contract for the scanner. The cost of a microcomputer for use as an input terminal should also be considered (if no terminal is available) to

replace the dumb terminals currently used for L&E data entry. Software for the scanner can be installed on the microcomputer.

Dumb terminals should be maintained as a backup method for entering data in the event the scanner is not functioning properly. Only one scanner would need to be installed on one microcomputer to apply scanner technology to L&E data entry. After training, implementation should be fairly easy. The new forms should offer challenge to employees as data elements are familiar and recognizable. The only new requirement would be to print very legibly.

Since the change in current techniques would not be very extensive with a scanner, acceptance by employees would be nearly assured. Indeed, the forms used for the scanner are in some ways better designed than current forms and would be an improvement in terms of readability, even without the use of a scanner. Each Grafenwoehr scanner form is specific to particular types of L&E submissions and all feature clearly defined boxes for entering the information. Operation of the scanner is also rather straightforward and should not pose acceptance problems for data entry clerks. The clerks will still have to use the keyboard to enter information from forms that cannot be scanned correctly and for correcting inaccurate data scanned from forms.

Effectiveness of Scanner Technology

If the scanner were to save one of the two full-time equivalent data entry positions, ROI, based on employee salary versus cost of the technology, new forms, training, and repair/maintenance, could occur after about 2.5 years (but this is not likely). Replacement of the scanner after intense usage over a few years would mean an additional future cost that would reduce the savings realized.

During initial implementation of the scanner, all employees performing data entry should be retained until scanner operators become proficient. Becoming accustomed to the scanner and its operation may actually consume more data entry clerk time at the outset. Use of a scanner results in a change from pressing a keypad to a feeding motion. If the time to complete both actions is nearly the same (and this is likely), reduction in clerk labor may not be realized at all. Errors currently made in transcribing information from the current cards (approximately 5 percent) would theoretically be eliminated. However, some cards may not scan correctly due to poor legibility; if this occurs as much as 5 percent of the time, no improvement will be realized in terms of time required to complete data entry.

Scanner technology should not be pursued if only for the purpose of reducing data entry clerk labor costs. However, other tangible and intangible benefits may be realized. During times when the scanner is not in use for L&E card reading, it could be available to scan documents and graphic images for other purposes. More legible L&E cards would also be obtained using the new card format. When the most optimistic ROI for scanner technology is compared with the potential ROI of other strategies, the scanner does not look promising.

Microcomputer Applications

Although all strategies in this report require the use of a microcomputer, different data entry interfaces are available. This evaluation focused on software application capabilities as separate from specific add-on hardware and software features (which are the focus of other strategies). Microcomputer interfaces include the keyboard, mouse, and touch screen. Microcomputer software applications include data base management, communications, and word processing. Communications software can be used to acquire data from or send data to other computers. This software also allows access to available electronic

mail systems. When a local area network (LAN) is available, network software provides the electronic mail capability for users on the LAN. USACERL has developed a program that allows seamless exchange of electronic mail between 3Com 3+ Mail (the network in use at Heidelberg) and Unix V mail which resides on the Sperry 5000/80 minicomputer. This product could prove useful at the Heidelberg DEH.

Microcomputers are available with a wide range of capabilities and must be selected based on the tasks that must be performed. It is beyond the scope of this report to develop a selection guide for microcomputers as such guidance is readily available from many public and private sources. USAEHSC provides selection guidance for microcomputers that are part of IFS-M.

Uses of Microcomputers

Each employee could use a microcomputer to enter L&E information. The collected data in this way could then be batch-fed to the minicomputer-based IFS system. As an alternative, the microcomputer could be used in a terminal mode to enter L&E data directly into the minicomputer if deemed appropriate from a security standpoint. As noted above, microcomputers are available with the keyboard, mouse, and touch screen modes of direct data entry, with the touch screen being the least common. Although many persons cannot type, most can press a few keys (although some persons who have never used a computer are uncomfortable with any such interface). However, neither mouse nor touch screen methods can allow efficient data entry unless a software application has been designed to acquire (download from the minicomputer host) and display values from which to choose (e.g., valid codes and employee data) to reduce the supplemental typing of these values.

Whichever entry method might be used, L&E input by the employee on a microcomputer is unlikely to save significant time. However improvement of data accuracy is a clear probability if the microcomputer is programmed to run an application that displays valid values for the employee. The user would then choose from a list. An intelligent formulation of such a list that would show valid codes for the employees, based on their shop or office assignment, would be desirable. The result would be that incorrect data would usually be avoided or rejected immediately. Rejection would offer the user a chance to retry at the time of entry. If all employees did enter their own data directly, central data entry clerk time would be reduced. However, much more time could be saved by providing software applications that allow key persons to retrieve L&E data from IFS so as to avoid multiple entry of that data into different microcomputers or onto paper reports.

Microcomputer Applications Implementation Issues

Microcomputer systems range between $1500 and $5000. The costs of acquisition, installation, training, maintenance, and administration also must be considered. Acceptance of additional microcomputers and network connections would largely depend on the software involved (i.e., ease of use) and the perceptions of new users. Again, effective training can improve acceptance.

Effectiveness of Microcomputers

If the hardware purchase is planned wisely and useful software is acquired, ROI is virtually assured in nearly any large organization, usually in the range of 150 percent (a return is frequently realized in small agencies and businesses as well). Microcomputer applications nearly always generate both tangible and intangible benefits. If the versatility of the microcomputer as a tool for performing tasks, relaying data, and electronic mail is realized in addition to using the system for L&E data acquisition needs, expansion of this technology could be expected to provide effective results.

13

Barcode Technology

A wide array of barcode-related products is available. Some devices are constantly attached to a microcomputer and others attach only at times to transfer data to it. The basic principal of barcode technology is to allow numeric, or in the case of Code 39 barcode symbology, alphanumeric characters to be represented by a pattern of varying width bars. When an optical sensor (barcode wand or swipe reader) is used to scan the pattern of bars, the value is translated quickly. When many digits must be copied or transcribed, a barcode reader can ensure that no errors occur in transferring the values represented by the pattern of bars. Hardware needed for barcode systems is neither large nor complex, making this technology easily portable (Appendix C).

Uses of Barcode Technology

The principal uses of barcode technology are for tracking physical items and entering or transferring information. Barcoding is prevalent in warehouses and in many point-of-sale operations.

For L&E data acquisition, barcode labels could be generated and attached to equipment for which usage time must be reported. If a portable barcode scanner were used, it would be possible for the employee to scan the number or code on the physical piece of equipment at beginning and end of use to record equipment usage time. As an alternative, printed pages of barcodes and descriptions of the equipment each represents could be made available in the shops. The barcode for the appropriate piece of equipment could be scanned at the time that other similarly represented information, such as valid task codes, is also scanned to form a complete L&E card entry, which would include a value for time of equipment use.

If barcode scanning were to become part of the L&E entry process at the shop level, each shop would need one microcomputer equipped with a barcode wand, the ability to extract valid information from the minicomputer host, and a means to print barcode symbols for scanning by employees. A dot matrix printer is adequate for printing scannable barcodes. It would not be necessary to purchase multiple hand-held or belt-slung barcode reading units. Barcode products are available that allow multiple wand units or swipe readers to connect to a single microcomputer or directly to a minicomputer. However, such a configuration is not feasible for Heidelberg because little or no control or checking of input would be possible.

Barcode Implementation Issues

A simple barcode system would undoubtedly reduce entry costs and improve data accuracy. L&E data is nearly all numerical, although Code 39 barcode symbology can handle a complete entry that contains alphabetical characters. Software to support barcode technology varies. Some products have software that can be configured to format the flow of barcoded information, usually in the form of an ASCII* stream, to the microcomputer from a portable unit. The simpler barcode products provide keyboards for entry of barcode symbol values into the microcomputer. They also can act as a filter to print barcode symbols on paper instead of alphanumeric characters. These simpler barcode products would require a custom application for sending the data on to its minicomputer destination. Some effort would be required to tailor this application to the L&E data acquisition requirement (USACERL is currently conducting research into this area).

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*ASCII = American Standard Code for Information Interchange.

Implementation would require one properly equipped microcomputer for each shop. It is likely that Heidelberg already has enough microcomputers in administrative areas to handle the additional task of biweekly L&E entry for administrative personnel (shops do this task daily). Employee acceptance of barcode technology would likely be mixed, at first, but once each employee learned how to use a barcode wand, it should come to be regarded as just another standard procedure. It is expected that few employees would miss the old paper L&E cards.

Effectiveness of Barcode Technology

Barcodes can increase speed of data entry but most importantly offer giant leaps in improving data accuracy. As information can be entered in far less time than writing it by hand, and because data entry clerk time would be largely eliminated, labor costs for entering L&E data would be reduced such that return on investment would be realized and continue to climb after approximately 1 year. This is based on the assumption that there is a value to employee time savings and that the Shop Foreman's time currently devoted to L&E matters would be greatly reduced.

Pushbutton Stations

Elements of this technology include: (1) a pushbutton station (actually a small piece of terminal equipment) with a liquid crystal display (LCD) and pushbuttons representing alphanumeric characters and symbols that would be linked from remote locations to one microcomputer; (2) a data base; and (3) communications software for storing data and sending it to minicomputers or mainframe systems. Several options could be included, such as a bar code wand, a swipe reader that attaches to the side of the station, and employee badges that can be either pulled through the swipe reader or read with the barcode wand. If the only purpose is to read employee badges, acquisition of both the barcode wand and swipe reader would be redundant. However, the barcode wand could also input other information such as a work code printed on a list of valid codes as a barcode symbol. In this case, barcode filter software to convert information to barcodes for printing would be an important supplement and would not represent a major additional cost. The common Code 39 barcode symbology would be recommended for the barcode features of this product. Providing real-time accounting, this technology represents the evolution of the time clock but is designed to track far more than time and attendance. In fact, the manufacturer includes customization of the data base for buyer needs as part of the product sale, such that a complete turnkey product is the result.

Uses of Pushbutton Station Technology

Pushbutton stations and the types of job tracking for which they serve as an interface are particularly well suited to work environments where employees work on many different jobs that require accounting of resources expended and materials/equipment used. Although up to 100 remote pushbutton stations can be connected to a single microcomputer, the physical layout of DEH buildings would affect actual layouts and counts of stations and microcomputers.

Connection is made using three-wire 22-gauge RS485 cable up to 4000 ft total length in a daisy chain configuration. The microcomputer and pushbutton station can communicate via modem if absolutely necessary. This option requires a Hayes-compatible modem at each end plus an RS232 to RS485 converter supplied by the vendor. Direct connection of the pushbutton station terminals to the mini-computer is possible, but this arrangement would preclude benefits provided by the microcomputer software for this technology (e.g., the ability to generate reports). Data also can be entered at the

keyboard instead of the pushbutton station. An important advantage is that employees who are more comfortable with the keyboard need not be provided pushbutton stations.

The microcomputer software can send data to host systems. IFS supports a batch processing option. If the microcomputer to which pushbutton stations are connected is also connected to a 3Com network, and the minicomputer is also wired to the LAN via Ethernet cable, faster Transmission Control Protocol/Internet Protocol (TCP/IP) file transfers to the minicomputer are an option. If the optional bar code wand, swipe reader, and employee badges are acquired, barcoded data can be read efficiently, reducing the number of buttons that would need to be pushed to create an L&E entry.

Pushbutton Station Implementation Issues

The cost of implementation is approximately half that required to provide microcomputers to employees for L&E data entry. Installation requires that RS485 cable be run to each pushbutton station. Microcomputers, each with several connected pushbutton stations, could be networked on a 3Com Ethernet cable. Pushbutton stations are of fairly rugged construction, having been designed in anticipation of factory use. Low maintenance costs and strong vendor support can be expected.

Acceptance of pushbutton stations has been high due to ease of use and because they more closely resemble an electronic calculator than a computer keyboard. This forestalls adverse fear of using the device on the part of employees.

Target retail stores nationwide are equipped with pushbutton technology. Employees at a Target store in Champaign, IL were interviewed as to ease of using the pushbutton station to record labor hours and all reported that it is quite simple to use. Incorrect selections are easily cleared and reentered.

Pushbuttons representing characters and other miscellaneous symbols are pressure-sensitive and beep when pressed. Both 24-button (numeric) and 48-button (alphanumeric) pushbutton stations are available; the cost is the same for both models. Prompts to the pushbutton station user appear on the LCD to ask for specific data elements. The text of these prompts can be defined by the system installer or administrator. The ability to control these prompts would allow display of English or German, as appropriate, to Heidelberg DEH personnel.

Effectiveness of Pushbutton Station Technology

Printing and manufacturing operations have realized significant benefits from this technology. The DEHs at Heidelberg and other installations are undoubtedly well suited to benefit from pushbutton stations. The manufacturers provide customization and full turnkey support for their products and many successful installations have been reported.

The many reports possible using the software are an important source of product effectiveness. These reports could show L&E costs and usage by job, operation, and shop. Data can be automatically compared to established standards and input into the system to obtain variance reports based on productivity or other topics. Reports can be generated overnight, allowing managers to review the previous day's activity at the beginning of the work day.

An employee could make an L&E entry at any time, such as at the completion of a work unit or at the end of each day. Or, the employee could begin an entry at the start of work on a certain order and complete it later when the work has been completed. The system's ability to track time in and out

immediately could reduce errors in the time submitted for orders that could otherwise be erroneous due to an inability to remember exactly how time was used.

Because employees can enter L&E data very quickly with the pushbutton station, and because data can be exchanged with the host system frequently, significant savings in both employee and data entry clerk labor are likely. Pushbutton stations need not be supplied for those who prefer to use the keyboard for entry, as noted earlier. Valid codes from the host can be stored in the microcomputer in order to prevent invalid entries at the pushbutton stations attached to it. The microcomputer downloads valid data to each pushbutton station with which each entry will be compared. Each station can store up to 5000 records. When the employee entry reaches the microcomputer at intervals specified in the software setup, additional verification occurs. The result is a microcomputer file to send to the minicomputer which represents records that should not, except on rare occasions, be rejected by the minicomputer. The reduction in time spent researching and correcting invalid L&E entries would be an important source of savings.

Comparison of Automation-Based Technologies

Table 1 compares projected costs for the four technologies studied. The figures in this table were derived assuming the equipment would undergo a pilot test before implementation on a larger scale.

The research cost associated with the pilot test is to identify modifications required for final implementation and possibly develop additional software or plans to effect a complete working system. Microcomputer applications and barcode technology would require development of software to be used for the L&E function. For pushbutton stations, configuration of vendor-supplied microcomputer software and some programming for exchange of data between the microcomputer and minicomputer would be required.

Onsite costs are those for local resources. Scanner technology requires special forms (Appendix B). Microcomputer applications and pushbutton stations require installation of cable. All automation-based technologies require onsite orientation and initial training for those involved with the pilot test.

Acquisition costs represent the purchase of hardware and software for each technology. Research costs to finalize the use of technology again include additional software programming work, except for scanner technology. In all cases, analysis of results and preparation of written findings would be required. Acquisition and ongoing costs per shop or group can be estimated to determine the total cost, based on the size of the facility and the extent of implementation.

It should be noted that ratings for overall factors relating to the potential success of implementing each automation-based technology are estimates only. Pilot testing would be required to affirm or modify these projected results.

Table 1

Comparison of Technology Costs

Cost Element	Scanner Tech.	Microcomputer Applications	Barcode Tech.	Pushbutton Stations
Research for pilot test	20K	150K	100K	60K
Pilot test	10-15K	5K	2K	5K
Acquisition for pilot test	75K	5K	3-8K	5-10K
Research to finalize system	20K	180K	80-100K	20-40K
TOTALS	125-130K	340K	185-210K	90-115K
Acquisition cost for final implementation per shop or group	n/a	5-8K	8-10K	6-8K
Yearly cost for administration, support, & training per shop or group	2K	12K	10K	4K
Ease of implementation	med.	low	med.	high
Expected degree of acceptance	high	med.	med.	high
Likelihood of addressing L&E problems	low	med.	med.	high
Expected ROI over 3-year period	low-1.1:1	med.-1.5:1	med.-1.8·1	high-2.5:1

18

5 CONCLUSIONS AND RECOMMENDATIONS

USACERL has investigated the Heidelberg DEH's current methods of L&E data acquisition. Areas of weakness were identified, as were opportunities to exploit automated data acquisition. The market was then surveyed for automation technologies that could possibly serve the DEH's needs.

Of the automation-centered strategies discussed in this report, the pushbutton station has the highest potential for success in terms of overall cost of implementation, employee acceptance, proven quality, availability of support, and ROI. It provides the option to read barcodes, but does not require barcodes to be the input method.

It is recommended that pushbutton stations be evaluated in depth for use at the Heidelberg DEH. If the evaluation verifies the findings of this study, it is recommended that a pushbutton system be pilot-tested at Heidelberg.

In addition, an educational program should be implemented stressing the purpose, importance, and benefits of L&E data submission. The existing paper system should also be upgraded. Detailed guidance and materials to improve the paper system could be developed easily by the Heidelberg DEH in consultation with USACERL. Regardless of which automation strategy may be implemented, improvement of this manual system is an important and worthwhile effort.

Expansion of LAN connectivity, including acquisition of additional microcomputers, should be pursued to improve data distribution, communications, and problem resolution. The complexity of daily work at the Heidelberg DEH and the multiple building locations of offices and shops are not conducive to frequent face-to-face communications. Although telephone conversations are possible, disruptions would be reduced and productivity enhanced when more communications are via electronic mail at the initiators' and respondents' convenience. Linking microcomputers to either the present minicomputer, or to each other as an LAN, would greatly improve communications within the Heidelberg DEH. Increased connectivity between 3Com users and the minicomputer could help managers acquire the data they need from the minicomputer without rekeying L&E data into their microcomputers. Such elimination of redundant L&E data entry must be pursued if manhours are to be saved,

If data entry clerks and shops are equipped with networked microcomputers, many problems could be resolved through electronic mail communications. Current Work Order and Service Order lists or approved fascimiles of the orders could also be sent to shops by network users from the appropriate offices. This same information could be sent to pushbutton stations to prevent entry of invalid codes.

The cost of microcomputers for the shops could be delayed if funds are insufficient for both microcomputers and pushbutton stations. One microcomputer could likely drive all pushbutton stations, with one station per shop. However, the acquisition of a microcomputer for each shop should be considered in addition to purchase of microcomputers for administrative offices not yet so equipped. Although the need for a microcomputer in the shop may not be considered extremely important at this time for direct support of L&E data acquisition, other short- and long-term benefits could be realized. Each shop foreman could become familiar with the use of microcomputer applications such as word processing and electronic mail. This computer literacy can ease the implementation of any automation-centered L&E data acquisition system that may be installed.

The results of the Grafenwoehr DEH scanner test should be reviewed when they become available. These results should be helpful in showing whether scanning printed L&E cards is an effective strategy. Knowledge to date has failed to indicate that scanner usage would provide significant improvements or cost savings, but a follow-up on this issue should be pursued to gain more insight into scanner technology. The results of the USACERL barcode research also should be reviewed when available. This research concerns the feasibility of various barcoding configurations for acquiring data as input to the IFS-M (Appendix C).

In selecting any automated system for L&E data acquisition, the DEH should consider compatibility with IFS-M. It is essential to coordinate with appropriate elements of USAEHSC, which is responsible for fielding.

The findings of this study could potentially apply to other DEHs as well. However, any decision to implement data acquisition equipment must be made on a case-by-case basis.

APPENDIX A:

L&E AND RELATED FORMS

LABOR AND EQUIPMENT UTILIZATION

For use of this form, see AR 420-17; the proponent agency is USACE.
READ PRIVACY ACT STATEMENT ON REVERSE BEFORE COMPLETING FORM.

	TRANS-ACTION CODE	DATE (DATUM)		SHOP CODE	EMPLOYEE NUMBER
		MO	DA		

EMPLOYEE NAME	1			
	F	M	2	C
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

DOCUMENT NUMBER				FACILITY (GEBAEUDE)				TASK		LABOR		EQUIPMENT		

Column headers: REQ. ID (22-23) | SERIAL NUMBER (AUFTRAGS-NUMMER) (24-28) | FY (29) | TYPE (30) | NUMBER (31-37) | SUFFIX (38-39) | PHASE CODE (40-41) | COMP. CODE (42) | CODE (43-45) | UNITS COMPL. (46-47) | LABOR CODE (48-52) | TIME HOURS (53-54) | TENTHS (55) | EQUIPMENT CODE (56-59) | TIME HOURS (60-61) | TENTHS (62) | COMPLETE (63)

Column numbers: 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63

IJO/SOO WORK ORDER (3 rows)

SO SERVICE ORDER (9 rows)

PM PREVENTIVE MAINTENANCE (8 rows, each with "M" in TYPE column 30)

OTHER (2 rows)

Column numbers: 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63

DA FORM MAR 83 4288(AE)   EDITION OF OCT 79 IS OBSOLETE.

SIGNATURE (Supervisor)

Note: actual forms are larger; size has been reduced here for easier presentation.

22

FY 89

For use of this form, see PR 420-17 and DA Pam 420-6, the proponent agency is the Office of the Chief of Engineers

DESCRIPTION OF WORK

SOO FOR ERMD ADMINISTRATION PERSONNEL

(PAGE-2-)

REMARKS: ERMD DIV

PHASE	SHOP CODE	SKILL	WK CLASS CD	PHASE DESCRIPTION	INSPECT CIV/MIL	LABOR HOURS	LABOR COST	MATERIAL COST	EQUIPMENT	REMARKS
08	44X	H	MGT BRANCH	2	560000	99999	0	0 0	0	
08	44X			2	515009	98145	0	0 0	0	
09	34X	M	TYPING OF LTG FORMS	2	50289	10453	0	0 0	0	
10	34X	M	OVERTIME HRS	2	200	13598	0	0 0	0	
11	35X	M	PROG+BUDGET BRANCH	2	5000	70050	0	0 0	0	
11	35X	M	MISC DUTIES	3	3086	43234	0	0 0	0	
12	44X	M		N	1595	20500				
13	44X		ERMD OFC		500					

TOTALS: 69,968   1,115,200

0147 add ~3

Po.
19.9.88

SERVICE ORDER

MENT: _____   FACILITY: F04308

JOB DESC: IM POLIZEI- RAUM AUGENSPUELE UEBERPRUEFEN

REMARKS: SHORT JOB DESC: CHECK EYEWASH

REQ NAME: WEBER   PHONE: 7020   F04308

DATE REC: 07/07   ACCOMPLISH ON: /   PRIORITY: 2
TIME REC: 10:05

TASK CODE: 99   TASK UNITS: 002   WORK CL: 1   RETIRE CD: 86

FUNCH SF: _____ OTHER FUND: GGFR   COMP CD: ___   SHOP: 03

APPROVED BY: _____ OCCUPANT SIGNATURE: _____

11° BIS 13° Uhr

****
FM1 C   LABOR AND EQUIPMENT UTILIZATION

DOCUMENT: 862792 18   DATE: __/__   SHOP: 03X   FAC#/SUF: F04308

SOC SEC#: _____   COMP CD: __   TASK CD: 99 TASK UNITS: 002

LABOR CD: _____   LABOR HR: ___ EQUIP CD: _____ EQUIP HRS: _____

OF CD: __   REMARKS:

****
M1 C   LABOR AND EQUIPMENT UTILIZATION

DOCUMENT: 862789 18   DATE: __/__   SHOP: ___   FAC#/SUF: F04308

SOC SEC#: _____   COMP CD: __   TASK CD: __ TASK UNITS: _____

LABOR CD: _____   LABOR HR: ___ EQUIP CD: _____ EQUIP HRS: _____

OF CD: __   REMARKS: _____

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103.35

2 Monteure a.2.54s 54
1 Vorarbeiter   0.54
1 Anfahrt

24

SOGs-RIJQs For FY 89

Refuse Collection: Shop 23X
50-00007-9S Phase 1 OMA   APC   GMBA
.   2 PHV DODDS   .   GMBA
.   3 MTV DODDS   .   GMBA
.   4 PHV   .   GMBB
.   5 MTV   .   GMBB
.   6 LH   .   GMBC

DEH Motor Pool: Shop 25X
50-00008-9S Phase 1 OMA   APC   GMBE

All Shops of DEH: SSL Material:
1A-00009-9S   1-14 OMA   APC   GXEB 4FS.

Fringe Material All Shops DEH:
1A-00010-9P Phase 1-10   APC   GXEB 1FS.

Shop Stock PM:
1A-00011-9S Phase 1-10   APC   GXEB 1FS.

Carpenter Maintenance: Shop 01X
1A-00013-9J Phase 1 OMA   APC   GXEA 1FS.

Replacement Hand Tools: All Shops
1E-00016-9J Phase 1-20 OMA   APC   GXEA

Emergency Standby:
50-00015-9S Phase 1 OMA   APC   GMFA

Generator Maintenance: Shop 02X
50-00016-9J Phase 1 OMA   APC   GXAW
4Y-H0016-9J   1 PHV   .   GXAL
7B-D0016-9S   1 DODDS PHV   .   GMAC
A-D0016-9S   1 DODDS MTV   .   GMAC

Elevator Maintenance: Shop 02X
50-00017-9J Phase 1 OMA   APC   GXAX
9D-00017-9J   1 Off.Cl. PHV .   GXBX
7A-D0017-9J   1 DODDS MTV   .   GXBX

Oil Burner Maintenance: Shop 06X
87-B0018-9S Phase 1 FH PHV   .   GJDC
A-D0018-9S   1 DODDS PHV   .   GXAM

PM Mechanic: Shop 06X
1A-00018-9S Phase 1 OMA   .   GJFA

Steamfitter Maintenance: Shop 10X
50-00001-9S Phase 1 OMA   APC   GJDB
.   2 PHV   .   GJDC
.   3 MTV   .   GJDC
.   4 DODDS MTV   .   GJDB
.   5 DODDS PHV   .   GJDB

Sanitation Maintenance: Shop 13X
50-00002-9J Phase 1 OMA   APC   GXAA
4Y-0002-9J   1 PHV   .   GXAZ
7A-0002-9J   1 MTV   .   GXAZ
7A-0002-9J   1 DODDS MTV   .   GXAZ
7B-0002-9J   1 DODDS PHV   .   GXAZ

Sewer Maintenance: Shop 14X
50-00003-9J Phase 1 OMA   APC   GXAA
4Y-0003-9J   1 PHV   .   GXAB
9A-0003-9J   1 MTV   .   GXBX
7B-0003-9J   1 DODDS PHV   .   GXBX
7A-0003-9J   1 DODDS MTV   .

Mechanical Maintenance: Shop 06X
50-00004-9J Phase 1 OMA   APC   GXAM
4Y-0004-9J   1 PHV   .   GXAL
7A-0004-9J   1 MTV   .   GXAL
50

Heating Operation Maintenance: Shop 20X
50-00005-9   Phase 1 OMA   APC   GJDB
.   2 PHV   .   GJDC
.   3 MTV   .   GJDC
.   4 DODDS PHV   .   GJDB
.   5 DODDS MTV   .   GJDB

Pest Control: Shop 21X
50-00006-9   Phase 1 OMA   APC   GMCA
.   2 PHV   .   GMCB
.   3 MTV   .   GMCB
.   4 DODDS PHV   .   GMCA
.   5 DODDS MTV   .   GMCA
.   6 LH   .   GMCC

APPENDIX B:

L&E FORMS USED AT GRAFENWOEHR

LABOR AND EQUIPMENT UTILIZATION
TYPE: SERVICE ORDER
(DAILY)

PLEASE PRINT LIKE THIS. USE ONLY CAPITAL LETTERS

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R |

| S | T | U | V | W | X | Y | Z | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 |

DATE — MONTH DAY

WORK ORDER

DOCUMENT NUMBER | **LABOR** | **EQUIPMENT** | COMPLETE

| REQ. ID | SERIAL No. | FY | TYPE | PHASE CODE | CODES (P1 P2 P3 P4 P5) | TIME (HRS MIN) | CODE | TIME (HRS MIN) | COMPLETE |

SERVICE ORDER

| REQ. ID | SERIAL No. | FY | TYPE | FACILITY No. | SUFFIX | COMP | TASK | UNITS | BLOCK 4 | COMPLETE |
| 4 MARK HERE FOR BLOCK IGNORE | LABOR CODES (P1 P2 P3 P4 P5) | HRS MIN | EQ CODE | HRS MIN |

| REQ. ID | SERIAL No. | FY | TYPE | FACILITY No. | SUFFIX | COMP | TASK | UNITS | BLOCK 5 | COMPLETE |
| 5 MARK HERE FOR BLOCK IGNORE | LABOR CODES (P1 P2 P3 P4 P5) | HRS MIN | EQ CODE | HRS MIN |

| REQ. ID | SERIAL No. | FY | TYPE | FACILITY No. | SUFFIX | COMP | TASK | UNITS | BLOCK 6 | COMPLETE |
| 6 MARK HERE FOR BLOCK IGNORE | LABOR CODES (P1 P2 P3 P4 P5) | HRS MIN | EQ CODE | HRS MIN |

| REQ. ID | SERIAL No. | FY | TYPE | FACILITY No. | SUFFIX | COMP | TASK | UNITS | BLOCK 7 | COMPLETE |
| 7 MARK HERE FOR BLOCK IGNORE | LABOR CODES (P1 P2 P3 P4 P5) | HRS MIN | EQ CODE | HRS MIN |

| REQ. ID | SERIAL No. | FY | TYPE | FACILITY No. | SUFFIX | COMP | TASK | UNITS | BLOCK 8 | COMPLETE |
| 8 MARK HERE FOR BLOCK IGNORE | LABOR CODES (P1 P2 P3 P4 P5) | HRS MIN | EQ CODE | HRS MIN |

Codes
H Annual Leave
J Sick Leave
K Compensatory Time Taken
L Administrative Leave / Holiday Leave
N Military Leave
P Maternity Leave / Leave Without Pay
Q Home leave
S Meetings
T Training / Unavoidable Delay

NON - PRODUCTIVE - PERIODS

| FROM DAY | TO DAY | CODE | TIME (HRS MIN) |

Labor Codes
P1	P2
1 Direct Labor	A Basic Rate - Normal
2 Indirect Labor	B Overtime
3 Direct Supervision	C Holiday Work
4 Indirect Supervision	D Sunday

Signature

28

LABOR AND EQUIPMENT UTILIZATION
TYPE: ADMIN (BIWEEKLY)

PLEASE PRINT LIKE THIS IN CAPITALS ONLY.

1 2 3 4 5 6 7 8 9 0

FROM: MONTH | DAY

TO: MONTH | DAY

WORK ORDER

DOCUMENT NUMBER					LABOR							EQUIPMENT			COMPLETE
REQ ID	SERIAL NUMBER	FY	TYPE	PHASE CODE	CODES					TIME		CODE	TIME		
					P1	P2	P3	P4	P5	HRS	MIN		HRS	MIN	

LABOR CODES

Position 1 (P1)
1 Direct Labor
2 Indirect Labor
3 Direct Supervision
4 Indirect Supervision

Position 2 (P2)
A Basic Rate - Normal
B Overtime
C Holiday Work
D Sunday
1-9 Military Grade

Position 3 (P3)
G Night Work Differential GS CAT 3
A Military Regular Time
B Military Overtime

NON - PRODUCTIVE - PERIODS

FROM DAY	TO DAY	CODE	TIME HRS	MIN

CODES
H Annual Leave
J Sick Leave
K Compensatory Time Taken
L Administrative Leave/Holiday Leave
M Jury Duty
N Military Leave
P Maternity Leave/Leave Without Pay
Q Home Leave
R Shore Leave
S Meetings
T Training/Unavoidable Delay

29

LABOR AND EQUIPMENT UTILIZATION
TYPE: UO & SOO
(DAILY)

PLEASE PRINT LIKE THIS. USE ONLY CAPITAL LETTERS.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R

S	T	U	V	W	X	Y	Z	1	2	3	4	5	6	7	8	9	0

DATE: ☐ MONTH ☐ DAY

WORK ORDER

DOCUMENT NUMBER					LABOR			EQUIPMENT		COMPLETE
REQ. ID	SERIAL No.	FY	TYPE	PHASE CODE	CODES	TIME		CODE	TIME	
					P1 P2 P3 P4 P5	HRS MIN			HRS MIN	

Codes
H Annual Leave
J Sick Leave
K Compensatory Time Taken
L Administrative Leave / Holiday Leave
N Military Leave
P Maternity Leave / Leave Without Pay
Q Home leave
S Meetings

NON - PRODUCTIVE - PERIODS

FROM DAY	TO DAY	CODE	TIME
			HRS MIN

Labor Codes

P1		P2	
1	Direct Labor	A	Basic Rate - Normal
2	Indirect Labor	B	Overtime
3	Direct Supervision	C	Holiday Work
4	Indirect Supervision	D	Sunday

APPENDIX C:

DIAGRAMS OF AUTOMATION COMPONENTS

BARCODE INDUSTRIES

**WAND WORKS AS KEYBOARD EMULATOR TO SEND
VALUE OF BARCODE TO CURRENT SOFTWARE PROMPT,
REGARDLESS OF WHAT PROGRAM IS ACTIVE.**

INTERNAL
CARD

WAND
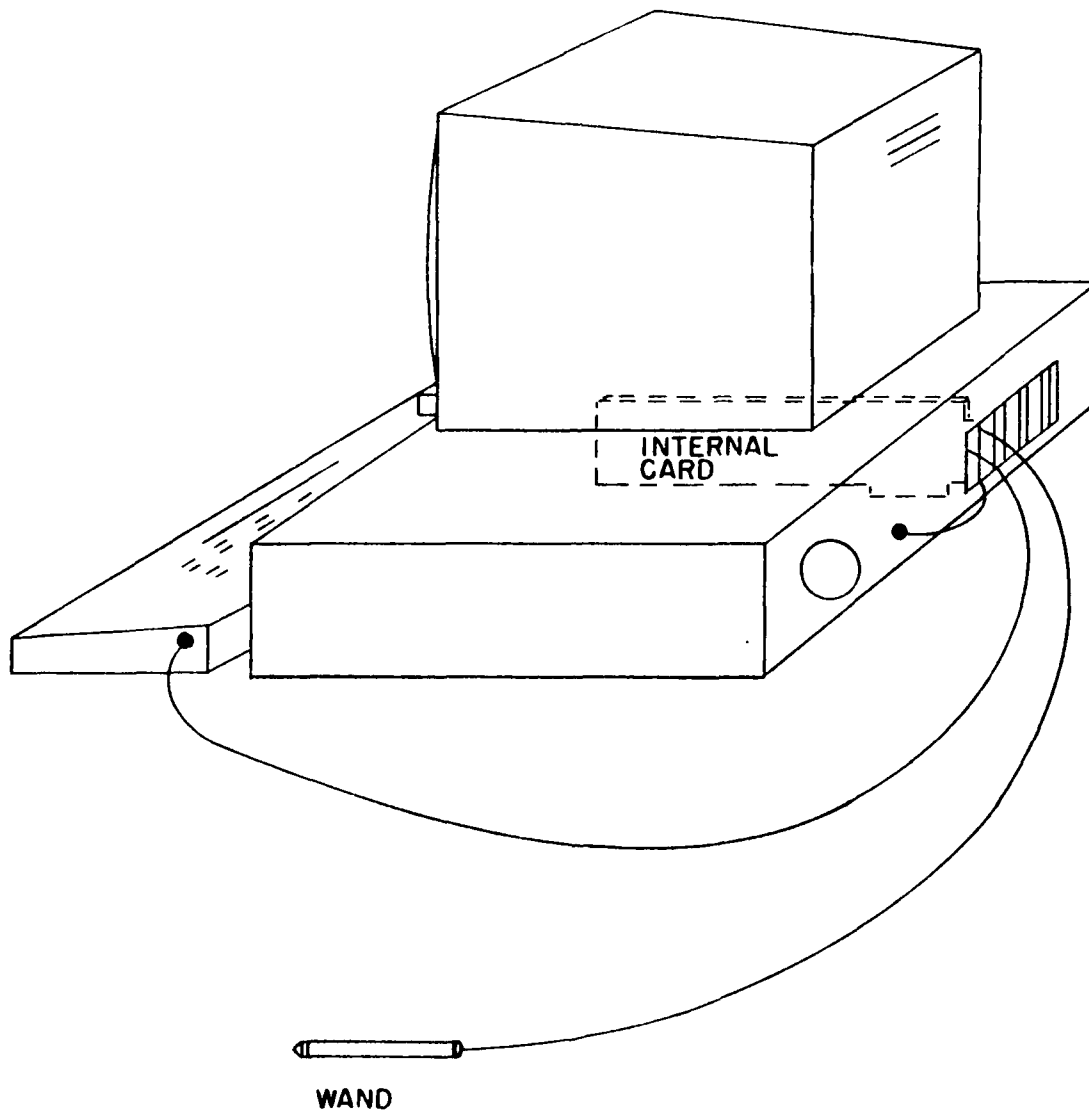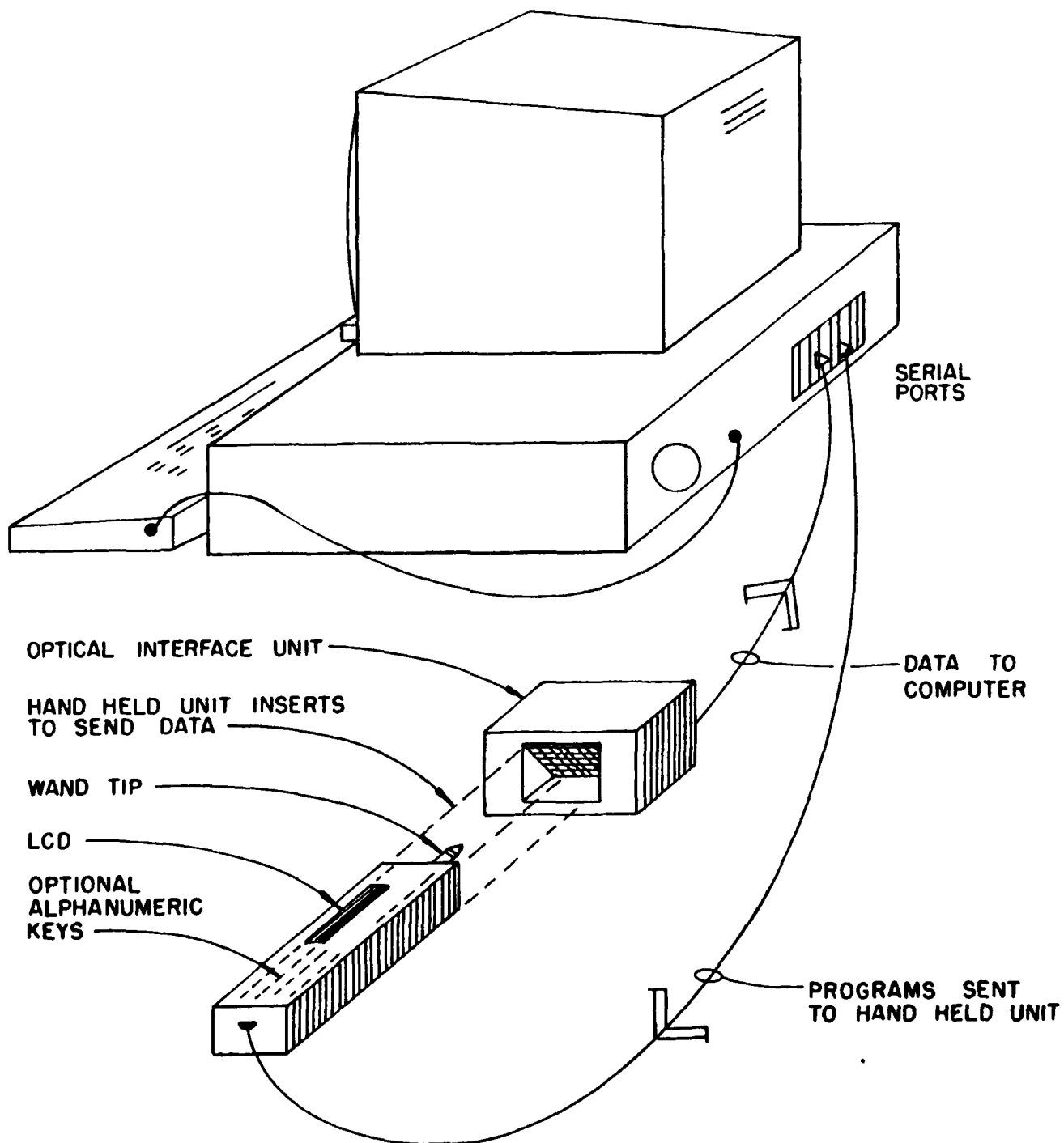
BARCODE FILTER SOFTWARE PROGRAM

**THIS SOFTWARE CAN BE USED TO TRANSLATE ALPHANUMERIC OUTPUT
FROM ANY PROGRAM INTO BARCODE SYMBOLOGY FOR PRINTING, A
'HOT KEY' CAN TOGGLE THIS SMALL MEMORY RESIDENT PROGRAM
ON AND OFF.**

NOTE

**COMBINING THE CAPABILITIES OF THE TWO PRODUCTS ABOVE
PROVIDES COMPLETE INPUT AND OUTPUT OF BARCODES. THESE
PRODUCTS ARE BEING EVALUATED AT USACERL.**

HAND HELD PRODUCTS, INC.

A PORTABLE HAND HELD UNIT CONNECTS TO THE MICROCOMPUTER
TO EXCHANGE DATA. DATA IS EXCHANGED AS AN ASCII STREAM
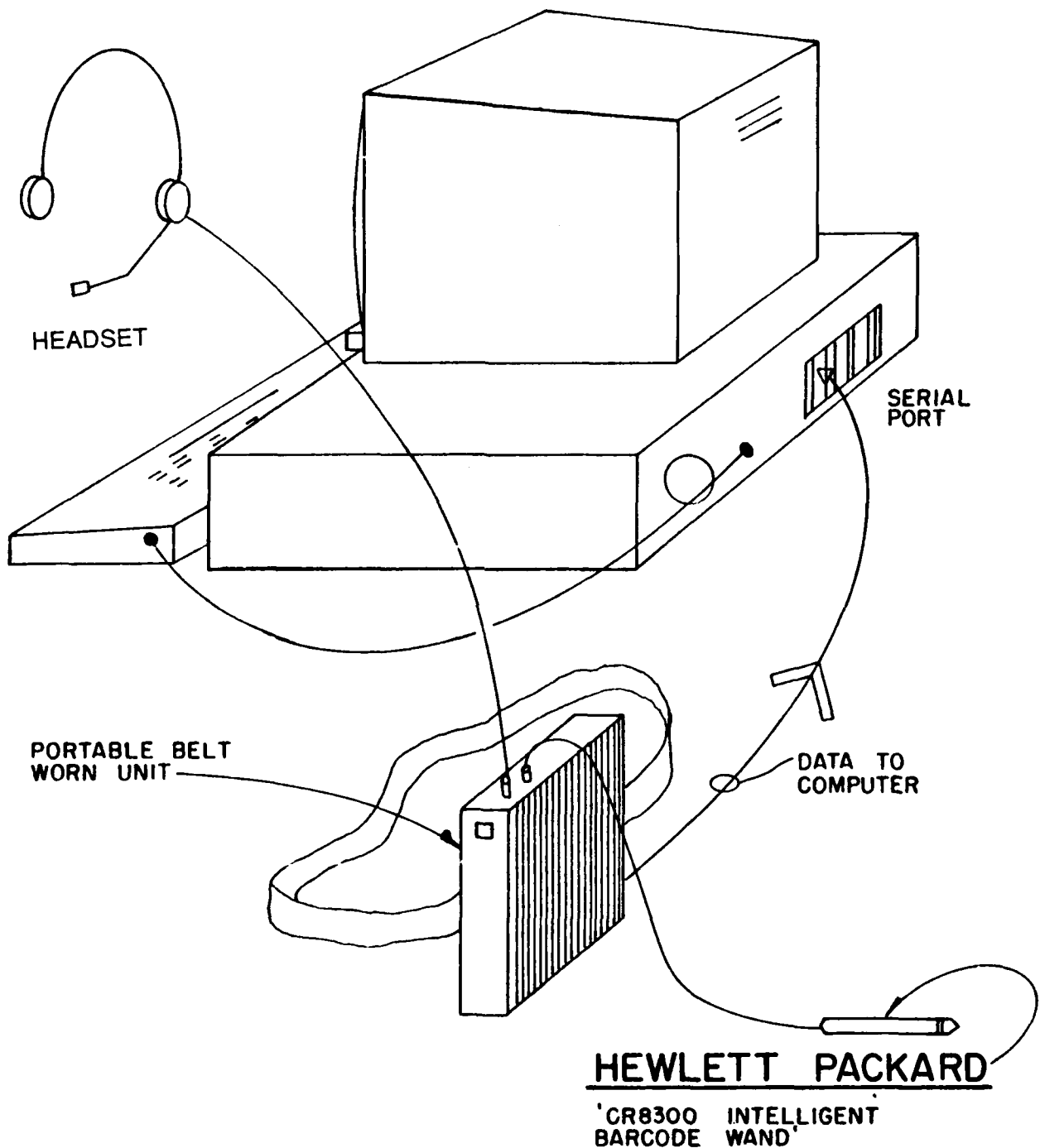CONTROLLABLE BY PROGRAMING.

SERIAL PORTS

OPTICAL INTERFACE UNIT

HAND HELD UNIT INSERTS
TO SEND DATA

WAND TIP

LCD

OPTIONAL
ALPHANUMERIC
KEYS

DATA TO COMPUTER

PROGRAMS SENT
TO HAND HELD UNIT

NOTE

THIS PRODUCT IS BEING EVALUATED AT USACERL

VOCOLLECT, INC.

THE 'TALKMAN' UNIT ACCEPTS VOICE AND BARCODE INPUT. THE VOICE RECOGINITION MUST BE TRAINED BY EACH USER. THE PORTABLE UNIT CONNECTS TO THE MICROCOMPUTER TO SEND DATA AS AN ASCII STREAM CONTROLLABLE BY PROGRAMING.

HEADSET

SERIAL PORT

PORTABLE BELT WORN UNIT

DATA TO COMPUTER

HEWLETT PACKARD

'CR8300 INTELLIGENT BARCODE WAND'

NOTE

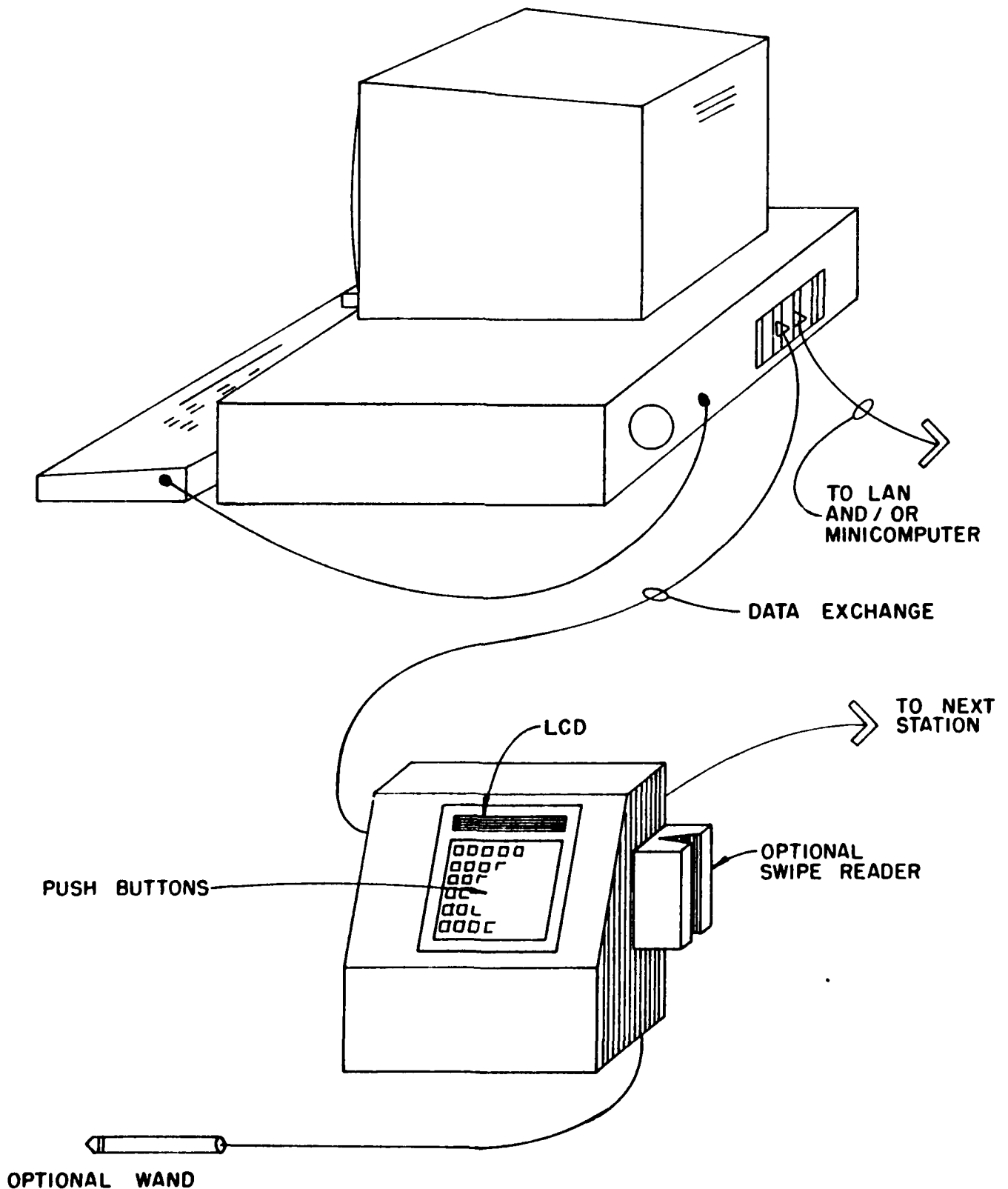THESE PRODUCTS ARE BEING EVALUATED AT USACERL

PREVALENT BARCODE CONFIGURATION

A NON-PORTABLE UNIT IS CONNECTED SO AS TO INTERRUPT THE
KEYBOARD CABLE TO BOTH INTERCEPT SIGNALS AND DRAW POWER
(ONE WATT). KEYBOARD INPUT IS PASSED THROUGH; BARCODE
SYMBOLS ARE TRANSLATED.

CONTROL UNIT

WAND

OPTIONAL
SWIPE READER
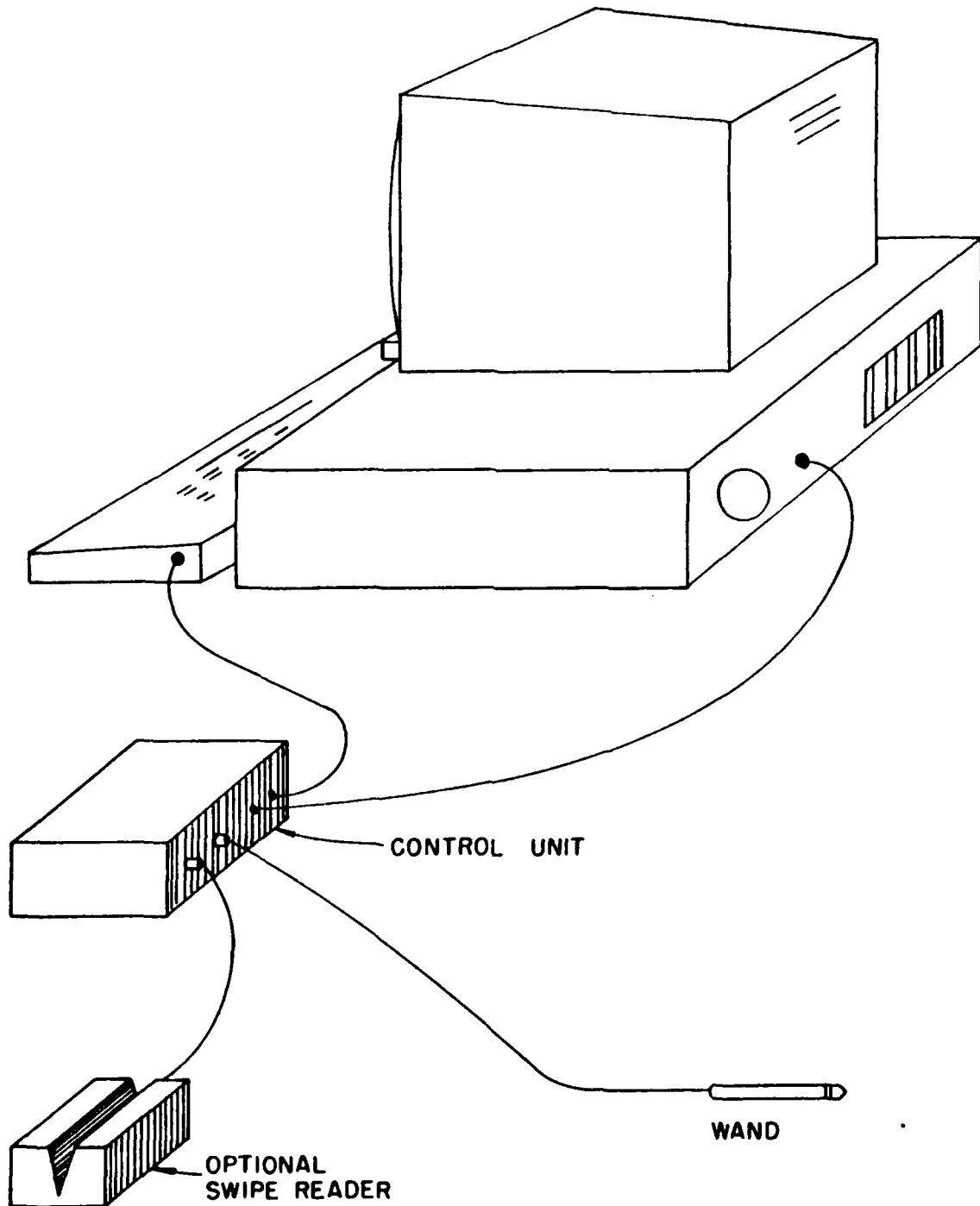
KRONOS, INC.

THE 'JOB KEEPER CENTRAL' PRODUCT IS A WALL MOUNTED PUSH
BUTTON STATION RECOMMENDED IN THIS REPORT.

TO LAN
AND / OR
MINICOMPUTER

DATA EXCHANGE

TO NEXT
STATION

LCD

PUSH BUTTONS

OPTIONAL
SWIPE READER

OPTIONAL WAND

ABBREVIATIONS

ASCII   American Standard Code for Information Interchange

CA   commercial activities

CONUS   continental United States

DEH   Directorate of Engineering and Housing

FY   Fiscal Year

USAEHSC   U.S. Army Engineering and Housing Support Center

IFDEP   Integrated Facilities Data Entry Program

IFS-M   Integrated Facilities System - Mini / Micro version

L&E   labor and equipment

LAN   local area network

LCD   liquid crystal display

O&M   operations and maintenance

OCR   optical character reader

ROI   return on investment

TCP/IP   Transmission Control Protocol/Internet Protocol

USACERL   U.S. Army Construction Engineering Research Laboratory

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    ATTN: AEAEN-ODCS
  V Corps
    ATTN: DEH (11)
  VII Corps
    ATTN: DEH (16)
  21st Support Command
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  USA Berlin
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  Allied Command Europe (ACE)
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    ATTN: SHIHB/Engineer 09055
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  USASETAF
    ATTN: AESE-EN-D 09019

26th Support Group (DEH)
  ATTN: CMESB 09102-5347

8th USA, Korea (19)

USA Japan (USARJ)
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  ATTN: Facilities Engineer 96343
  ATTN: DEH-Okinawa 96331

416th Engineer Command 60623
  ATTN: Facilities Engineer

AMC - Dir., Inst., & Svcs.
  ATTN: DEH (22)

FORSCOM (28)
  FORSCOM Engineer, ATTN: Spt Det. 15071
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HSC
  Ft. Sam Houston AMC 78234
    ATTN: HSLO-F
  Fitzsimons AMC 80045
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  Walter Reed AMC 20307
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INSCOM - Ch, Instl. Div.
  Arlington Hall Station 22212
    ATTN: Engr & Hsg Div
  Vint Hill Farms Station 22186
    ATTN: IAV-DEH

TRADOC (19)
  HQ, TRADOC, ATTN: ATEN-DEH 23651
    ATTN: DEH

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  Fort Huachuca 85613
    ATTN: Facilities Engineer (3)
  Fort Ritchie 21719

WESTCOM
  Fort Shafter 96858
    ATTN: DEH
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Fort Belvoir, VA
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                                184
                                1/91